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BIOLOGICAL INVESTIGATIONS OF TUTTLE CREEK RESERVOIR - KANSAS

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Federal Water Pollution Control Administration
Cincinnati, Ohio

1969

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TUTTLE CREEK RESERVOIR - KANSAS

by

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Region VI

Field Investigations Branch
Division of Technical Support
Federal Water Pollution Control Administration
United States Department of the Interior
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1969

BIOLOGICAL INVESTIGATIONS OF
TUTTLE CREEK RESERVOIR - KANSAS
1965 - 1968

At the request of the Army Corps of Engineers through the Missouri Basin Region, Federal Water Pollution Control Administration, biological studies were conducted on Tuttle Creek Reservoir. The purpose of these studies was to determine changes in productivity and downstream aquatic life in the Big Blue River resulting from the construction of Tuttle Creek Dam. The Army Corps of Engineers, Kansas State Department of Health and the Federal Water Pollution Control Administration have conducted surveys from 1965 through 1968 on Tuttle Creek Reservoir and the Big Blue River from Blue Rapids to Manhattan, Kansas (Figure 1). Interim reports have been issued on data thus far collected[1,2,3].

Tuttle Creek Reservoir has a total capacity of 2,346,000 acre-feet of which 1,933,000 are for flood control, 135,000 are for conservation purposes, and 228,000 are for sedimentation. The average annual reservoir inflow is 1,768 cfs, with instantaneous values ranging from 38 to 93,400 cfs. Releases from the conservation pool of Tuttle Creek Reservoir have ranged from 50 to several thousand cfs.

The Big Blue River basin is approximately 150 miles long and up to 129 miles wide and extends from south-eastern Nebraska to north-

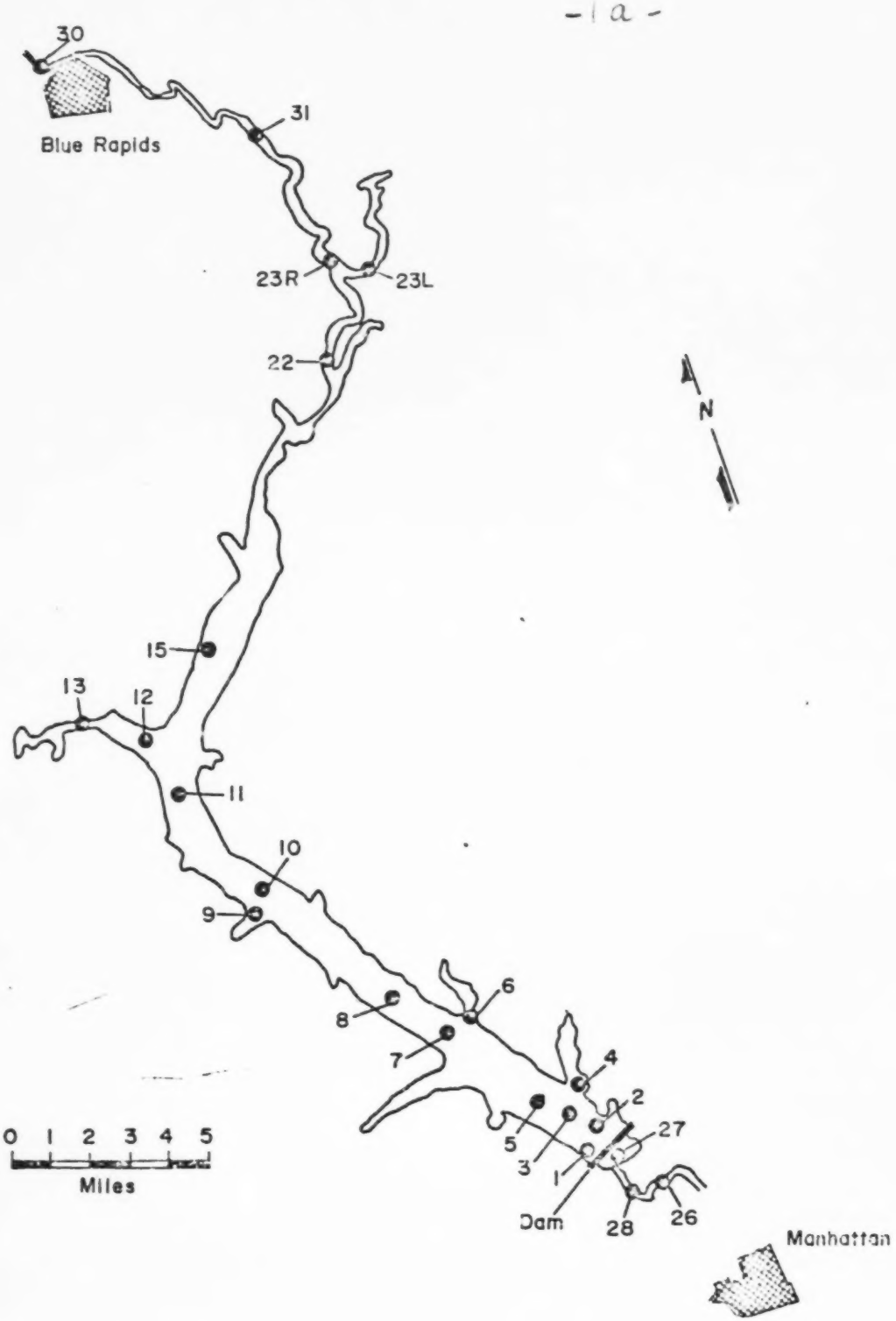

FIGURE 1. TUTTLE CREEK RESERVOIR, KANSAS, BIOLOGICAL SAMPLING STATIONS, AUGUST, 1965 - 1968.

eastern Kansas. The drainage area upstream from Tuttle Creek Dam is 9,556 square miles. The average annual precipitation increases from 22 inches in the upper watershed to 31 inches near the dam. Agriculture is the principal occupation of the 202,000 people living in the Basin.

METHODS

The Kansas State Department of Health determined temperature and dissolved oxygen (DO). Samples were returned to their laboratory for bacterial examination, biochemical oxygen demand (BOD), specific conductance, solids, silicon, pH, phosphate, calcium, manganese, sodium, potassium, sulfate, chloride, nitrate, fluoride, hardness, total alkalinity, turbidity and boron determinations. The Federal Water Pollution Control Administration personnel collected and preserved phytoplankton and bottom associated organism samples and water samples for soluble and total phosphorus, nitrate, ammonia and organic nitrogen determinations. Both agencies conducted the analyses according to Standard Methods[4]. Phytoplankton productivity was determined by DO differences occurring in light and dark bottles[5].

RESULTS AND DISCUSSION

PHYSICAL AND CHEMICAL

In 1964, two years after inundation, the initial oxygen demand of the organic materials in the reservoir bed reduced the concentration of dissolved oxygen (DO) in the deeper portions of the reservoir from 6.1 to 0.1 mg/l at Station 3. In subsequent years the DO depletion near the bottom has not been as severe. The minimum DO observed at Station 3 in 1968 was 2.3 mg/l.

LIGHT

The most significant physical or chemical aspect of Tuttle Creek Reservoir was the 6,629,000 tons of sediments carried into the impoundment annually. The particle size of the suspended sediment was very small (0.25 - 0.45 μ in diameter) and comprised of 54 percent clay, 40 percent silt, and 6 percent sand.

The depth of light penetration is dependent on the amount of materials suspended in the water. Tuttle Creek Reservoir is turbid most of the time because of suspended clay and silt. The depth of the euphotic zone (that depth to which one percent of the light can penetrate) has varied from 2.5 to 6 feet from 1964-1968. As indicated in Figure 2, the production of algae was dependent on the depth of the

euphotic zone and when the reservoir cleared sufficiently to permit light penetration to greater than 5 feet deep, algal populations greater than 1000/ml developed.

BIOLOGY

During the studies from 1965 to 1968, the number of algae upstream from Tuttle Creek Reservoir (Station 31) fluctuated from 1,854 to 15,700 algae/ml (Figure 3). These fluctuations do not have any pattern; however, the algal numbers upstream were usually greater than in the reservoir.

In the main section of the reservoir (Stations 15 - 1), wind kept the suspended sediment mixed vertically most of the year. This resulted in a reduction in the number of algae as the water passed through the reservoir (Figure 3). During August (1966-1968), the number of algae in the surface water of the main section of the reservoir was less than 1,650 per ml. Most of the algae were dead as a result of being covered with inorganic sediment and they often numbered less than 50 per ml. From February to March 1967, algae numbered in excess of 3,000 per ml in the surface waters because the waters were cleared by silt settling while the reservoir was partiall

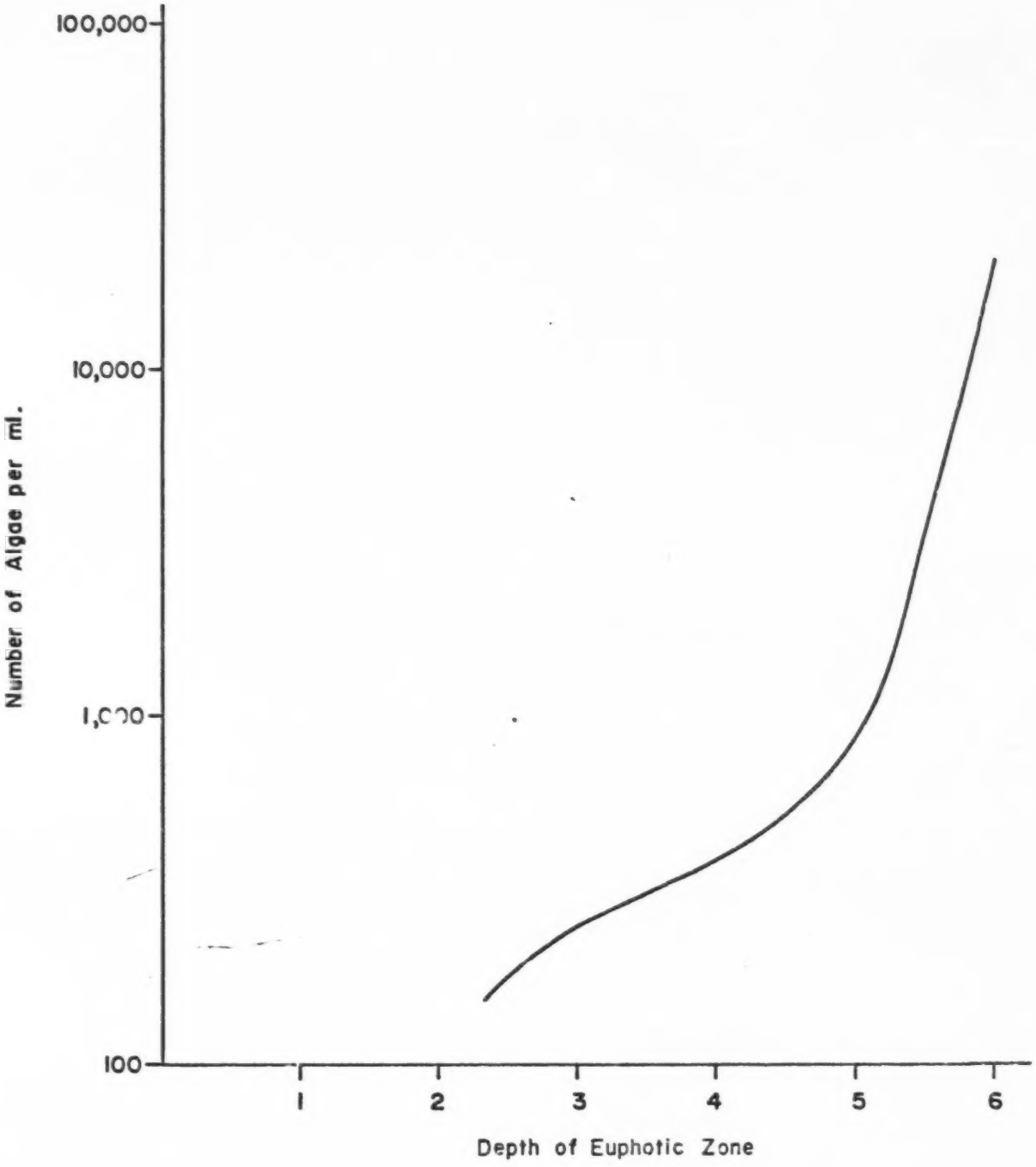

FIGURE 2. NUMBER OF ALGAE AS A FUNCTION OF THE DEPTH OF THE EUPHOTIC ZONE.

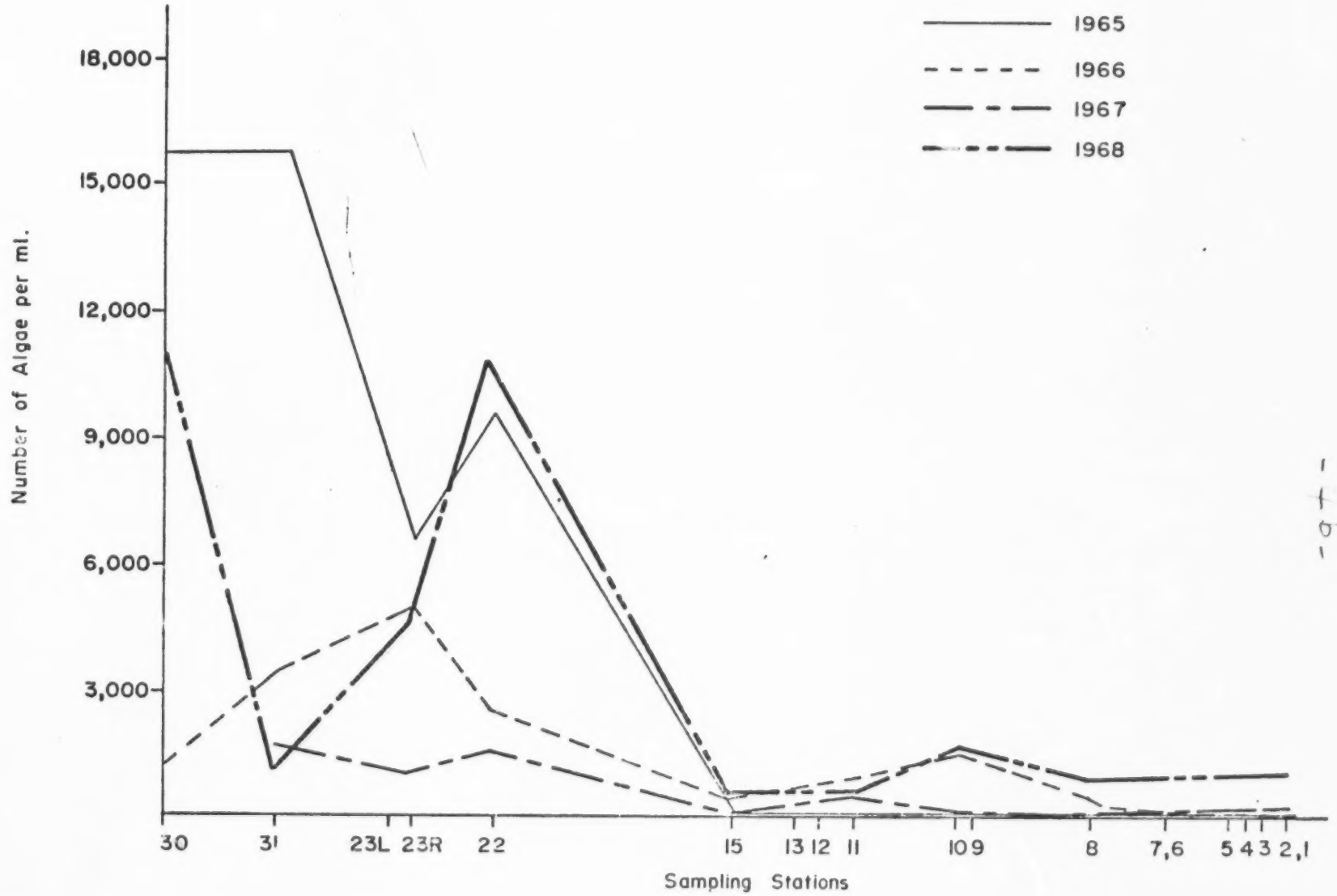

FIGURE 3. NUMBER OF ALGAE, TUTTLE CREEK RESERVOIR, 1965 - 1968.

ice covered and not receiving runoff. The low number of algae usually found in Tuttle Creek Reservoir were insufficient to support a population of bottom animals.

To determine the productivity of the algal population (gross primary production), a series of light and dark bottle studies were conducted at selected stations in 1966 and 1968. In the upstream reach of Tuttle Creek Reservoir, primary production was measured at 1,310 and 800 mg C/m^3/day at the one-foot depth in 1966 and 1968 respectively. Farther downstream near Randolph Bridge (Station 11), at the one-foot level, primary production was reduced from 900 to 240 mg C/m^3/day in 1966 and 1968 respectively. Near the dam (Station 1), the algal activity was zero.

Nutrients at concentrations of 15 µg/l total phosphorus (P) and 5 µg/l soluble phosphorus (P) were sufficient to produce algal growths greater than 80,000 per ml during periods when there was partial ice cover, no runoff, and reduced suspended silt. However, at other seasons algal counts were low because of reduced light penetration and the adherence of silt to algal cells, which caused their premature settling.

Phosphorus concentrations decreased as the water passed through the reservoir. For example in 1968, the concentration of total phosphorus

at the upstream end of Tuttle Reservoir (Station 22) was in excess of 2,000 µg/l. As the sediment settled, the concentration of total phosphorus decreased to 130 µg/l near the dam (Figure 4). The concentration of soluble phosphorus decreased from 110 to 80 µg/l in the reach from Station 22 to Station 1 (Table 1). In the impoundment, 80 percent of the phosphorus was soluble which indicated that there is very little utilization of phosphorus by algae in Tuttle Creek Reservoir.

During 1965 and 1966, collections of bottom animals typical of clean water were made on the Big Blue River near Blue Rapids, Kansas, 42 miles upstream from Tuttle Creek Reservoir Dam (Station 30). In subsequent years, high flows prevented sampling. In 1965 at Station 30, 6 kinds of organisms (49 per square foot) populated the bottom. In 1966 there were 11 different kinds numbering 332 per square foot. Eighty percent of these were clean water forms such as mayflies and caddisflies. Ten miles downstream from Blue Rapids (Station 31), the first station within the impoundment, sparse populations of bottom animals were found on recently exposed rocks. This reduced population and the elimination of all bottom animals in the main channel of the river, indicated that the settling of large quantities of silt and the decrease in water velocity had a detrimental effect on the bottom animals inhabiting the Big Blue River.

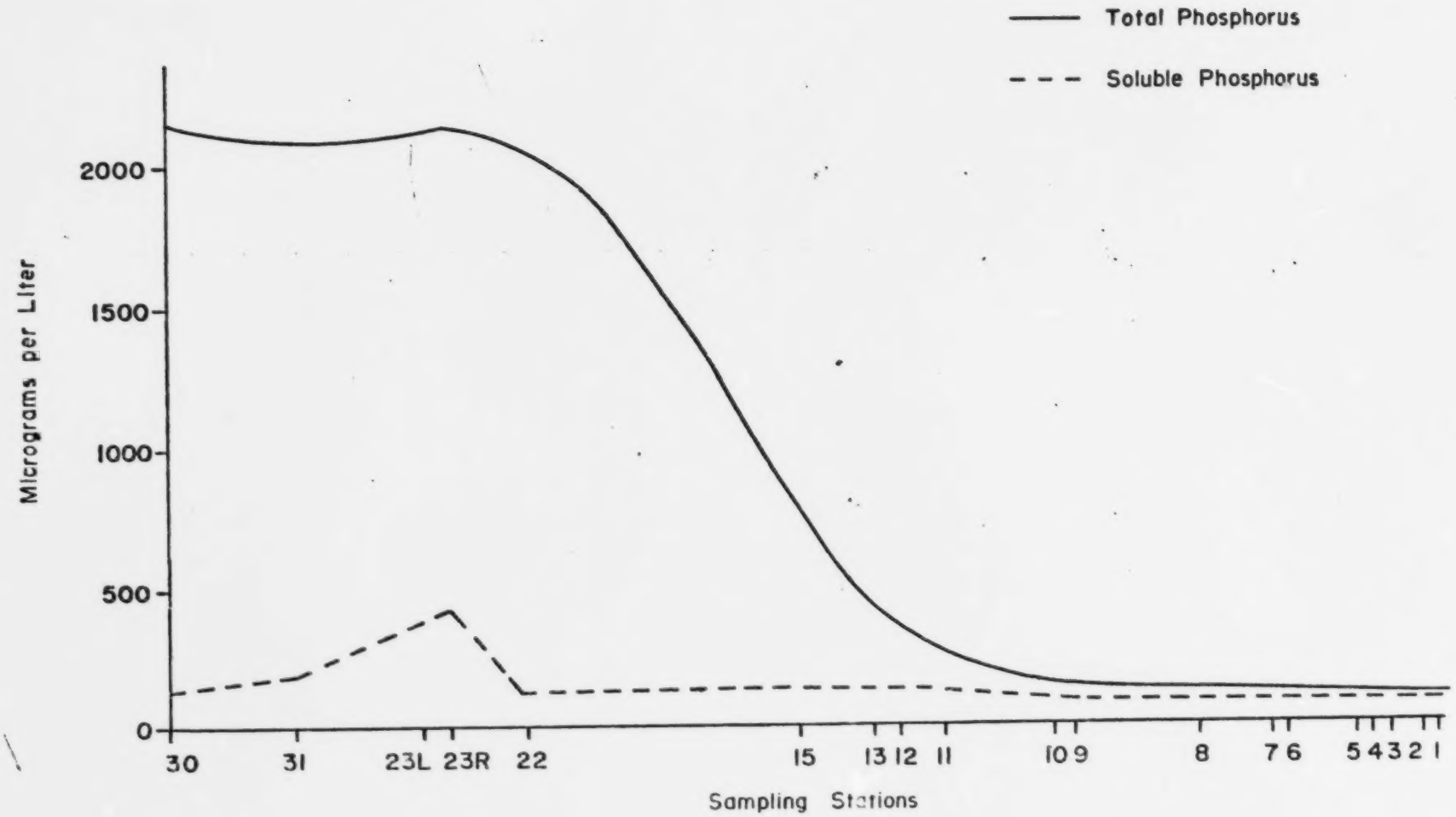

FIGURE 4. CONCENTRATIONS OF TOTAL AND SOLUBLE PHOSPHORUS, TUTTLE CREEK RESERVOIR, 1968.

Bottom animals in Tuttle Creek Reservoir, after increasing to a maximum population of 35 organisms per square foot at Station 8 in 1966, have declined to 1 per square foot in 1968 (Figure 5). During the years with the highest numbers, most of the bottom animals were phantom midges. In 1968, midges of the genera Coelotanypus and Tanypus were the predominant bottom animals. Inadequate food supply and unsuitable habitat resulting from excessive silt deposition curtailed the development of a bottom animal community.

Compared to the community of bottom animals upstream at Blue Rapids, the bottom animal community downstream from Tuttle Creek Reservoir was of poorer quality. Sampling at this location was difficult because wide variations in flow restricted the resident population to the center of the river and only during the 1966 survey was access satisfactory for representative sample collection. Clean water associated bottom animals such as mayflies and caddisflies comprised 60 percent of the animals downstream from Tuttle Creek Dam. Upstream, clean water associated forms made up 80 percent of the total bottom animals. In 1966 the bottom animals were reduced to 44 per square foot downstream from Tuttle Creek Dam compared to 332 per squa

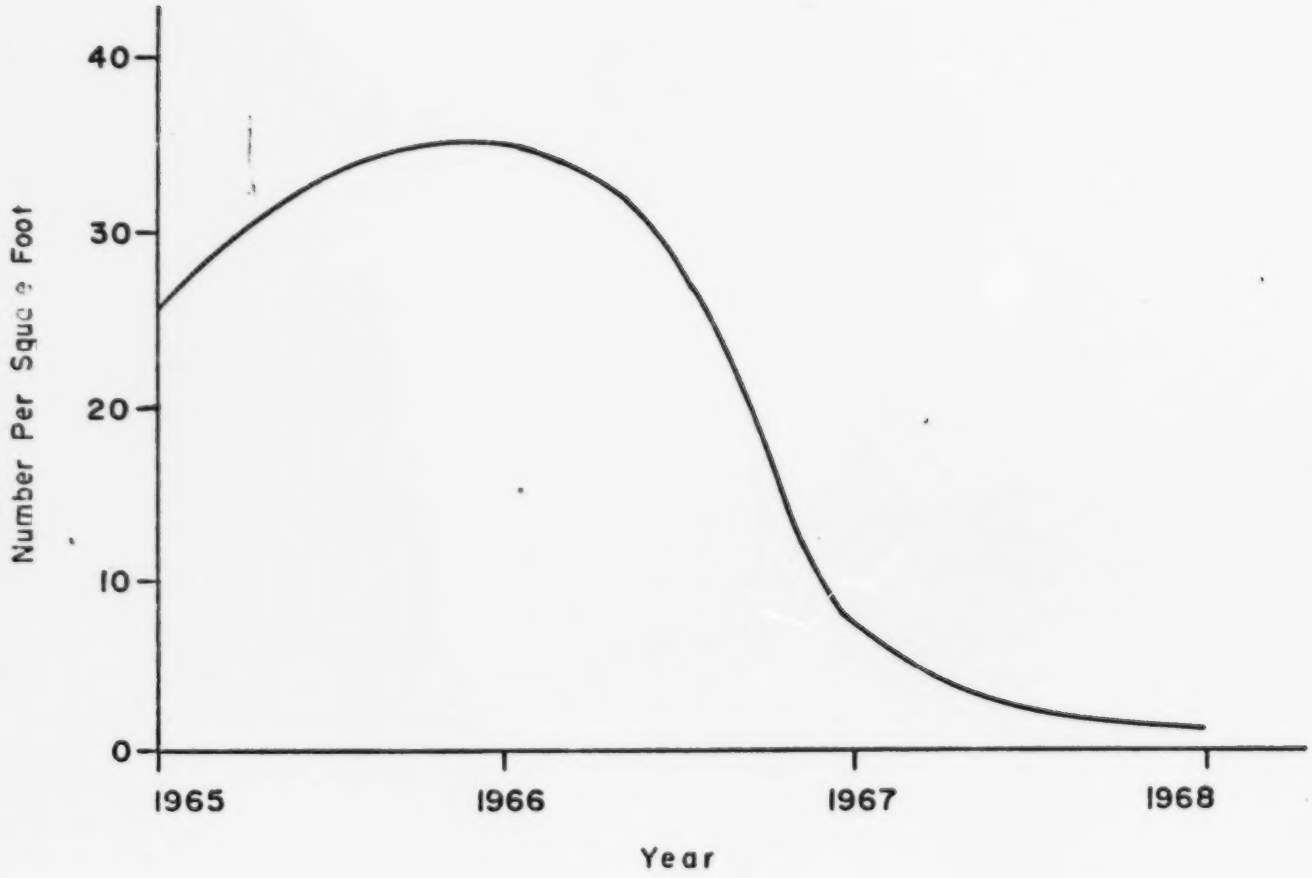

FIGURE 5. NUMBER OF BOTTOM ANIMALS, PER SQUARE FOOT, AT STATION 8, TUTTLE CREEK RESERVOIR

foot upstream at Blue Rapids. The quality of water discharged was improved through a reduction in silt, but because of wide variations in flow the population of bottom animals did not respond.

In conclusion, the productivity of the Big Blue River has not increased as the result of impounding Tuttle Creek. The number of algae in the impoundment was always less than observed upstream. In the impoundment, a desirable population of bottom animals has not developed because of an inadequate food supply and excess silt deposition. Aquatic life downstream from Tuttle Creek Reservoir has not been greatly altered by the impounding of the Big Blue River. Because of large fluctuations in flow, the improved water quality resulting from reduction in silt is of little benefit to the aquatic community.

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Table 1. Tuttle Creek Reservoir, Biological and Chemical Data

August 1968

Organisms	1	8	10	11	13	15	22	23L	23R	26	27	30	31	Relief Well
Phantom Midges														
Chaoborus	-	-	-	-	29	-	-	-	-	-	"	"	"	"
Midges											No Sample	No Sample	No Sample	No Sample
Coelotanypus	-	-	2	6	-	2	-	-	-	-				
Tanypus	-	-	4	3	-	-	-	-	-	-				
Spaniotoma	-	-	-	-	-	-	-	-	-	2				
Sludgeworms	-	1	-	-	15	-	-	-	10	-	"	"	"	"
Total Number of Kinds	0	1	2	2	2	1	0	0	1	1				
Total Number/Sq. Ft.	0	1	6	9	44	2	0	0	10	2				
Number of Algae/ml	1,188	1,155	1,650	660	2,112	792	11,220	3,762	4,520	957	12,342	10,890	1,254	
Chemical, mg/l														
NO_3-N, mg/l	0.4	0.4	0.4	0.4	0.3	0.9	1.4	0.5	0.3	0.5	0.01	0.03	0.03	0.02
NH_3-N, mg/l	0.08	0.04	0.05	0.01	0.12	0.18	0.48	0.13	0.51	0.10	0.22	0.32	0.34	0.03
Org-N, mg/l	0.6	0.4	0.7	1.3	1.1	2.3	5.2	1.1	5.2	0.9	0.8	5.8	5.5	0.6
µg/l														
Soluble P, µg/l	80	60	80	120	80	140	110	60	430	40	40	140	190	80
Total P, µg/l	100	120	120	270	170	770	2040	150	2130	230	130	2160	2070	430